

1       **TEMPERATURE SENSING DEVICE FOR SELECTIVELY MEASURING**  
2       **TEMPERATURE AT DESIRED LOCATIONS ALONG AN INTRAVENOUS**  
3       **FLUID LINE**

4  
5       **CROSS REFERENCE TO RELATED APPLICATIONS**

6       This application is a continuation-in-part of copending U.S. Patent Application Serial No.  
7 09/380,507, filed April 24, 2000, entitled "Method and Apparatus for Pressure Infusion and  
8 Temperature Control of Infused Liquids", which is a National Stage Application of PCT  
9 International Application No. PCT/US98/04199, filed March 3, 1998, entitled "Method and  
10 Apparatus for Pressure Infusion and Temperature Control of Infused Liquids", which claims  
11 priority from U.S. Provisional Patent Application Serial Nos. 60/040,885, filed March 3, 1997,  
12 entitled "Method and Apparatus for Measurement and Control of Temperature for Infused  
13 Liquids" and 60/062,315, filed October 17, 1997, entitled "Method and Apparatus for Pressure  
14 Infusion and Temperature Control of Infused Liquids". The disclosures of the foregoing patent  
15 applications are incorporated herein by reference in their entireties.

16       **BACKGROUND OF THE INVENTION**

17       Technical Field

18       The present invention pertains to temperature sensing devices for monitoring temperature  
19 of intravenous fluid. In particular, the present invention pertains to temperature sensing devices  
20 that monitor the temperature of intravenous fluids at any desirable location along a fluid line  
21 (e.g., an intravenous fluid line) to ensure a desired fluid temperature is maintained within the  
22 fluid line prior to entering a patient.

23       Discussion of Related Art

24       Intravenous (IV) fluids are typically infused within a patient utilizing a liquid filled bag  
25 or container and an IV fluid line for delivering fluids under gravity and/or applied pressure from  
26 the container to the patient. It is important in many situations that the temperature of the fluid  
27 within the IV line be maintained within a desirable and safe temperature range upon entering the  
28 patient so as to eliminate any potential for thermal shock and injury to the patient by the fluid.

29       Accordingly, the related art provides several devices that employ temperature sensors to  
30 monitor and/or control the temperature of fluid flowing within an intravenous or other type of

1 fluid line. For example, U.S. Patent No. 5,729,653 (Magliochetti et al.) discloses a device for  
2 heating a fluid to a body temperature prior to delivery of the fluid to a patient. In one  
3 embodiment, a fluid to be warmed prior to delivery to a patient can be passed through a flow  
4 through chamber disposed in the fluid delivery line. An electrically resistive heating element for  
5 heating the fluid can be molded into the chamber to heat the fluid from room or ambient storage  
6 temperatures to a body temperature of the patient. A probe of a temperature monitoring element  
7 can be used to monitor the temperature of the fluid exiting the chamber. In another embodiment,  
8 this information can be relayed back to a controller for controlling the power to the resistance  
9 element, and hence, the temperature of the fluid. In still another embodiment, an infrared  
10 temperature sensor can be used for monitoring the temperature of the fluid exiting the chamber  
11 by scanning through a window in the chamber outlet port or elsewhere in the fluid line. The  
12 device may further include an LED two-digit display of the exiting fluid temperature for visual  
13 temperature monitoring.

14 U.S. Patent No. 5,250,032 (Carter, Jr. et al.) discloses a heater for warming blood, plasma  
15 and other solutions flowing through an IV tube prior to entry into a patient. The heater is  
16 releasably secured to a patient and includes a housing having an elongated channel extending  
17 from one end of the housing to its other end. The channel is formed with an elongated slot  
18 against which a heating element is mounted. The heating element is controlled by a control  
19 circuit and powered by batteries. The control circuit may energize the heating element  
20 continuously or cyclically in response to sensed temperatures.

21 U.S. Patent No. 3,526,134 (Schaus) discloses a thermobulb mount for holding a  
22 temperature sensing element in a pipeline so as to prevent damage to the element which might  
23 otherwise be caused by fluid flow within the pipeline. The mount includes a body having  
24 threaded ends for connection in series with a pipeline, an installation boss with a hole through  
25 which the sensing element extends and a recess formed on the inside of the pipeline opposite the  
26 boss for supporting an outboard end of the sensing element.

27 U.S. Patent No. 5,829,880 (Diedrich) discloses a device including a T-type pipe  
28 combination including a medium conduction pipe and a connection piece projecting away from  
29 the pipe. The pipe is connected to tubing that supplies medium to and leads medium away from  
30 the pipe. A plug unit is disposed within the connection piece and includes a stopper supporting  
31 contact pins and a temperature sensor connected to those pins. The temperature sensor indirectly

1 measures the temperature of the medium flowing through the pipe. An electrical bush part is  
2 further secured to the connection piece via a bracket and is connected to the contact pins. The  
3 bush part housing includes contact bushes with electrical connecting lines that extend externally  
4 of the housing through openings defined therein.

5 U.S. Patent No. 4,138,890 (Brown) discloses a temperature indicating probe including  
6 a liquid-in-glass thermometer encased within a housing. The housing includes a series of  
7 tapered, cylindrical shaped portions separated by a step or shoulder, which are respectively  
8 insertable into variously sized standard medical appliance line openings or fittings, for sensing  
9 and indicating the temperature of the working fluids being carried through the line.

10 The related art suffers from several disadvantages. In particular, the Magliochetti et al.  
11 and Carter, Jr. et al. systems employ temperature measurement in combination with temperature  
12 control, thereby increasing system complexity and costs to employ those systems for temperature  
13 measurement functions. Further, the size and/or mounting requirements for those systems tend  
14 to restrict system application to particular sections of an IV line. Thus, operators are required to  
15 estimate, or adjust system settings to compensate for, conditions at desired IV line sites outside  
16 the system application range. This tends to lead to inaccuracies in fluid temperature control and  
17 measurement for the desired sites, thereby risking injury to a patient. In addition, the Carter, Jr.  
18 et al. system measures temperature for temperature control of fluid without providing any  
19 temperature indication to an operator, thereby enabling infusion of fluid of unknown temperature  
20 into a patient.

21 The Schaus, Hollweck et al. and Diedrich devices are designed for non-medical fluid  
22 systems. Accordingly, these devices are employed for non-sterile applications and are ill-suited  
23 for medical applications that require sterility. Although these devices measure fluid temperature,  
24 the devices generally do not provide a displayed temperature to an operator. Thus, fluids may  
25 attain inappropriate temperatures without notice to the operator which may lead to undesirable  
26 conditions or consequences. The Brown device requires an operator to manually observe a  
27 thermometer and determine a fluid temperature therefrom. This is distracting to the operator and  
28 permits possible operator error to be introduced with respect to the fluid temperature  
29 measurement, thereby enabling infusion of fluid at an inappropriate temperature and risking  
30 injury to the patient.

## 31 **OBJECTS AND SUMMARY OF THE INVENTION**

1           Accordingly, it is an object of the present invention to measure the temperature of a fluid  
2 within an IV line via a temperature sensing device selectively securable to a desired site along  
3 that line.

4           It is another object of the present invention to obtain an accurate and reliable temperature  
5 indication of fluid within an IV line at any desired location along that line and display the  
6 temperature indication to an operator.

7           Yet another object of the present invention is to removably secure a temperature sensing  
8 device to an IV line and facilitate measurement of fluid temperatures at varying locations along  
9 that line.

10          Still another object of the present invention is to facilitate re-use of a temperature sensor  
11 with a temperature sensing device to measure the temperature of sterile fluid while maintaining  
12 fluid sterility.

13          A further object of the present invention is to measure and display the temperature of  
14 fluid within an IV line via a line fitting employing a temperature sensor coupled to a display  
15 device.

16          The aforesaid objects may be achieved individually and/or in combination, and it is not  
17 intended that the present invention be construed as requiring two or more of the objects to be  
18 combined unless expressly required by the claims attached hereto.

19          According to the present invention, a temperature sensing device measures the  
20 temperature of a fluid at selected locations along an IV fluid line. The device is secured to a  
21 selected portion of the IV line and includes a temperature sensor for measuring fluid flowing  
22 within that line. The device is coupled to a temperature display device in communication with  
23 the temperature sensor to provide an indication of measured fluid temperature to an operator.  
24 The temperature sensing device may include a housing removably secured to a selected portion  
25 of the IV line. The housing includes a pivotable lower cover to engage the line and a temperature  
26 sensor disposed proximate the engaged line section to indirectly measure fluid temperature. The  
27 temperature sensor is coupled to a temperature display device to display the measured  
28 temperature to an operator.

29          Alternatively, the device may be in the form of a holder secured to a selected portion of  
30 the IV line. The holder is movable along the line and includes a temperature sensor disposed  
31 proximate the line to indirectly measure fluid temperatures at line locations secured to the holder.

1 The temperature sensor is coupled to a temperature display device to display the measured  
2 temperature to an operator.

3 The temperature sensing device may alternatively include a housing with upper and lower  
4 members pivotally connected to each other and receiving an IV line therebetween. The lower  
5 member includes a temperature sensing tip configured to pierce the secured portion of the IV  
6 line. The tip directly contacts and measures temperature of fluid within the line, and is coupled  
7 to a temperature display device to display the measured temperature to an operator. Further, the  
8 temperature sensing device may include a resilient member having a spiral or overlapping  
9 configuration to surround a selected portion of the IV line. The resilient member includes a  
10 temperature sensing tip configured to pierce the selected IV line portion. The tip directly  
11 contacts and measures temperature of fluid within the line, and is coupled to a temperature  
12 display device to display the measured temperature to an operator.

13 The temperature sensing device may be in the form of a fitting securable to selected  
14 portions of the IV line. The fitting may be a 'T'-type fitting including a fluid conduit and a  
15 projection including a thermally conductive receptacle to receive a temperature sensor. The  
16 receptacle is disposed in direct contact with the fluid to enable temperature measurement by the  
17 temperature sensor. The sensor may alternatively be disposed in direct contact with the fluid  
18 (e.g., without employing the receptacle), while a securing mechanism may further be employed  
19 to releasably secure the temperature sensor to the fitting. The temperature sensor is coupled to  
20 a temperature display device to display the measured temperature to an operator. Alternatively,  
21 the fitting may be a 'Y'-type fitting and include a temperature sensor configured in the form of  
22 a syringe or needle for insertion into a fitting branch to measure fluid temperature. The sensor  
23 is coupled to a temperature display device to display the measured temperature to an operator.  
24 The sensor may further be employed with a sheath to permit re-use of the sensor while  
25 maintaining fluid sterility.

26 The above and still further objects, features and advantages of the present invention will  
27 become apparent upon consideration of the following detailed description of specific  
28 embodiments thereof, particularly when taken in conjunction with the accompanying drawings,  
29 wherein like reference numerals in the various figures are utilized to designate like components.

30 **BRIEF DESCRIPTION OF THE DRAWINGS**

1        Fig. 1 is an exploded front view in elevation and partial section of a temperature sensing  
2 device attached to an IV fluid line in accordance with the present invention.

3        Fig. 2 is a view in perspective of the temperature sensing device of Fig. 1 coupled to a  
4 temperature display device for use with an infusion apparatus in accordance with the present  
5 invention.

6        Fig. 3 is a front view in elevation and partial section of a temperature sensing device for  
7 an IV fluid line in the form of a holder in accordance with the present invention.

8        Fig. 4 is a view in perspective of a temperature sensing device including a housing  
9 securable to an IV fluid line to measure temperature of fluid therein in accordance with the  
10 present invention.

11       Fig. 5 is a front view in elevation of a locking mechanism of the temperature sensing  
12 device of Fig. 4.

13       Fig. 6 is a view in perspective of a temperature sensing device for an IV fluid line  
14 including a spiral or overlapping configuration in accordance with the present invention.

15       Fig. 7 is a front view in elevation of the temperature sensing device of Fig. 6.

16       Fig. 8 is a view in perspective of a temperature sensing device for an IV fluid line in the  
17 form of a line fitting in accordance with the present invention.

18       Fig. 9A is an exploded view in perspective of a temperature sensing device in the form  
19 of a line fitting and including a thermally conductive receptacle for receiving a temperature  
20 sensor in accordance with the present invention.

21       Fig. 9B is a view in perspective of the thermally conductive receptacle of the temperature  
22 sensing device of Fig. 9A.

23       Fig. 10 is a view in perspective of a temperature sensing device including a securing  
24 mechanism in accordance with the present invention.

25       Fig. 11 is a side view in elevation of the temperature sensing device of Fig. 10.

26       Fig. 12A is a side view in elevation and section of the securing mechanism of the  
27 temperature sensing device of Fig. 10.

28       Fig. 12B is a bottom view in perspective of the securing mechanism of Fig. 12A.

29       Fig. 13 is a view in perspective of a temperature sensing device including an alternative  
30 line fitting configuration in accordance with the present invention.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

A temperature sensing device for measuring the temperature of a fluid within an IV fluid line at operator selected locations along the line is illustrated in Fig. 1. Specifically, a temperature sensing device 2 may be removably affixed around any selected portion of an IV line 30. The device includes a housing member 4 and a cap member 6, wherein each member is typically constructed of an appropriate material (e.g., plastic) having suitable insulative properties to ensure the accuracy of temperatures measured for the portion of a fluid line disposed between the housing and cap members. Housing member 4 has a generally rectangular configuration and includes a channel 10 extending between the longitudinal ends of the housing member and having suitable dimensions to receive a selected portion of fluid line 30 and a temperature sensor 20. However, the housing member may have any geometric configuration suitable for operation of the device as described below. Channel 10 typically includes a sensor receiving area 12, a fluid line receiving area 14 and an open bottom portion defined in a bottom surface 16 of the housing member that provides access to the channel to permit an operator selected portion of IV line 30 to be received within fluid line receiving area 14. Sensor receiving area 12 has a configuration complimentary to temperature sensor 20 to receive and secure the temperature sensor therein. By way of example only, temperature sensor 20 and the sensor receiving area 12 include a generally cylindrical configuration. Fluid line receiving area 14 of channel 10 has a generally rectangular configuration and extends from a lower section of the sensor receiving area. The fluid line receiving area further includes a tapered section that narrows the channel toward bottom surface 16 of the housing member. The tapered section is further dimensioned to frictionally engage and secure the IV line within the device.

Temperature sensor 20 may be implemented by any type of conventional or other temperature sensor (e.g., RTD, IR, NTC, thermistors, thermocouples, etc.) suitable for operation of the device as described below. The temperature sensor may be secured within sensor receiving area 12 of the housing member channel in any suitable manner (e.g., adhesion, frictional engagement, etc.). The temperature sensor is positioned within the sensor receiving area and is disposed proximate and/or in direct contact with the IV line portion disposed within fluid line receiving area 14 to obtain a temperature measurement of fluid within that line.

Cap member 6 is generally rectangular and pivotally connected to the housing member bottom surface to secure a portion of the IV line within channel 10. The cap member basically

1 facilitates insertion and removal of an IV line portion within the channel and may be connected  
2 to the housing member via a pin 22. The pin is inserted through a pivotal aperture 24 defined  
3 within the cap member toward a cap member front corner (e.g., front left corner as viewed in Fig.  
4 1). Pin 22 extends through the cap member and is received within a pin receiving aperture 26  
5 that is defined within housing member bottom surface 16 and substantially aligned with aperture  
6 24. The pin may be secured within the pin receiving aperture in any suitable manner (e.g.,  
7 threaded engagement, adhesion, etc.). The cap member pivotal aperture preferably includes  
8 transverse cross-sectional dimensions that are slightly greater than those of the pin to permit  
9 rotational movement of the cap member with respect to the pin and the housing member when  
10 the pin is secured within pin receiving aperture 26. Alternatively, the housing and cap members  
11 may be connected to each other via hinges or any other suitable connection mechanism.

12 The temperature sensing device is typically disposed along IV line 30 of an infusion  
13 apparatus as illustrated in Fig. 2. Specifically, the infusion apparatus includes an IV pole 42, a  
14 solution bag 40 suspended therefrom and IV line 30 enabling flow of solution from the solution  
15 bag to a patient. Sensing device 2 is disposed along line 30 and is in communication with a  
16 temperature display or monitor device 50 to provide an operator with indications of fluid  
17 temperature measurements at operator selected locations along the IV line. The monitor device  
18 may communicate with the fluid device in any suitable manner (e.g., electrical line, RF, IR, etc.).  
19 Monitor device 50 typically includes a temperature display 52 (e.g., LED or LCD), a plurality of  
20 input devices or buttons 54 and a processor to control monitor device operation and determine  
21 fluid temperature based on signals received from the temperature sensing device. The display  
22 typically indicates the temperature measured by temperature sensor 20, and may further indicate  
23 a desired or set-point temperature entered by the operator via buttons 54. The monitor device  
24 may further provide an indication when the temperature measured by sensor 20 falls within a  
25 desired range of the set-point temperature. In addition, the monitor device may include a printer  
26 and/or data recorder to print and/or record data associated with the measured IV fluid  
27 temperature. Exemplary monitor devices for use with the temperature sensing device include a  
28 Fluke 50S hand-held thermometer available from Fluke Corporation and a printing thermometer  
29 available from Extech Instruments.

30 Operation of the temperature sensing device is described with reference to Figs. 1-2.  
31 Initially, an operator rotates cap member 6 with respect to housing member 4 to expose channel

1 10. If temperature sensor 20 is not already disposed within the housing member, the sensor may  
2 be inserted and secured within sensor receiving area 12. The temperature sensing device is  
3 subsequently secured to IV line 30 by inserting a selected portion of the IV line within fluid line  
4 receiving area 14 of housing member channel 10 such that part of the IV line wall frictionally  
5 engages the tapered section within the channel. Upon securing the IV line portion within the  
6 channel, cap member 6 is maneuvered to secure the IV line within the temperature sensing  
7 device. Temperature sensor 20 measures the temperature of fluid within the secured IV line  
8 portion and provides temperature measurements to monitor device 50 for display to an operator.  
9 The temperature sensing device may further provide temperature measurements of fluid at other  
10 locations within the IV line by placing the device at any location along the IV line (e.g., as shown  
11 by arrow 60 in Fig. 2) as described above. For example, temperature sensing device 2 may be  
12 placed along IV line 30 toward IV solution bag 40 on IV pole 42 or, alternatively, toward the  
13 infusion point on the subject (not shown). Thus, the device allows the operator to determine the  
14 fluid temperature at any point along the IV line with minimal disruption to the infusion  
15 procedure. The temperature sensing device further ensures proper mounting of the temperature  
16 sensor with respect to the IV line, thereby enabling a precise temperature measurement of fluid  
17 (i.e., not skin or ambient temperature) at specific locations within the IV line. The temperature  
18 sensing device may be removed from the IV line by moving cap member 6 with respect to  
19 housing member 4 to expose channel 10, and removing the secured portion of IV line 30 from  
20 the channel. The temperature sensing device may subsequently be removably attached to and  
21 utilized with additional IV lines without compromising sterility of the fluid.

22 A temperature sensing device in the form of a holder is illustrated in Fig. 3. Specifically,  
23 device 100 includes a substantially flat rectangular base 102 having curved prongs 104, 106  
24 extending away from the base and curving toward each other. A generally rectangular platform  
25 112 is attached to base 102 and has dimensions that are greater than those of the base. The  
26 platform may include various fastening mechanisms (e.g., hook and loop fasteners, tape, gel, etc.)  
27 and may be fastened to a patient (e.g., an arm or other body portion) during temperature  
28 measurement along the IV line. Prongs 104, 106 are resilient and may be spread from each other  
29 slightly to allow insertion of a portion of the IV line and the temperature sensor therebetween as  
30 described below. Prongs 104, 106 each respectively include a longitudinally extending groove  
31 114, 116 and a transversely extending projection 108, 110. The grooves are defined in the prongs

1 between projections 108, 110 and base 102, while the projections extend from the distal sections  
2 of the respective prongs toward each other. The projections basically serve as a stop to guide the  
3 temperature sensor in an appropriate position within device 100.

4 A groove or channel 120 is defined in base 102 and extends in a longitudinal direction.  
5 The groove is dimensioned to receive and engage a selected portion of IV line 30. A temperature  
6 sensor 124 is dimensioned to be frictionally retained between prongs 104, 106 with sensor  
7 portions disposed within grooves 114, 116 and projections 108, 110 serving as a stop for the  
8 temperature sensor. The temperature sensor is disposed proximate the IV line portion located  
9 within groove 120. Thus, the temperature sensor engages and is in direct contact with the IV line  
10 portion disposed within channel 120 to obtain an accurate temperature measurement of the liquid  
11 flowing within that IV line portion. The temperature sensor is substantially similar to and  
12 functions in substantially the same manner as the temperature sensor described above. In  
13 operation, temperature sensor 124 is typically inserted between prongs 104, 106 after insertion  
14 of a portion of fluid line 30 within groove 120 of base 102. Placement of the sensor between the  
15 prongs allows the device to slide along the IV line while maintaining direct contact between the  
16 sensor and the IV line. A temperature display or monitor device (not shown), substantially  
17 similar to the monitor device described above, is in communication (e.g., via a wire, RF or IR  
18 communication, etc.) with temperature sensor 124 to display temperature of fluid within the  
19 secured IV line portion measured by the temperature sensor.

20 The temperature sensing device may provide a direct measurement of fluid temperature  
21 within a selected portion of the IV line by puncturing the line with a temperature sensing probe  
22 as illustrated in Figs. 4-5. Specifically, temperature sensing device 200 is securable to an  
23 operator selected portion of an IV line 230. The device includes a generally rectangular housing  
24 201 with an upper member 202 and a lower member 204. The upper and lower members are  
25 generally rectangular with rounded corners and are pivotally connected to each other at  
26 corresponding sides via a hinge member 205. This allows selective engagement between an  
27 internal surface 206 of upper member 202 and an internal surface 208 of lower member 204 as  
28 described below. However, the upper and lower members may be connected to each other in any  
29 suitable manner to facilitate opening and closing of the housing. The lower and upper members  
30 of the housing may be constructed of any suitable rigid materials (e.g., plastic, metal, etc).

1           A generally semi-circular groove 209 is defined within the internal surface of the upper  
2 member, while the lower member internal surface includes a generally semi-circular groove 210  
3 defined therein in substantial alignment with groove 209. The grooves extend along their  
4 respective internal surfaces between the longitudinal ends of the upper and lower members to  
5 collectively form a longitudinal channel through the housing when the upper and lower members  
6 engage each other. The longitudinal channel is appropriately dimensioned to receive a selected  
7 portion of IV line 230 for directly measuring temperatures of fluids flowing within the received  
8 IV line portion.

9           A temperature probe 212 is embedded within lower member 204 and extends from  
10 groove 210 toward an opposing, external surface of the lower member. Specifically, the probe  
11 includes a base 250, supports 252, 254 and a sensing tip 213. Base 250 is substantially  
12 cylindrical in the form of a disk and includes supports 252, 254 disposed on the base top surface.  
13 The supports are generally semi-circular and each have dimensions less than those of the base  
14 in order to reside on the base top surface. Sensing tip 213 is substantially cylindrical including  
15 a tapered distal end configured in the form of a spike and dimensions greater than those of the  
16 supports. The sensing tip is disposed on the base top surface between supports 252, 254. The  
17 supports encompass the sensing tip proximal portion while the tip distal portion extends from  
18 the distal ends of the supports through the lower member internal surface and within groove 210.  
19 Sensing tip 213 is preferably constructed of stainless steel and is configured to pierce the wall  
20 of the IV line when the line is inserted into the housing and the housing is subsequently  
21 manipulated to a closed state. Alternatively, sensing tip 213 may project slightly from groove  
22 210 to obtain a temperature measurement by contacting (e.g., without piercing) the IV line. The  
23 temperature sensing tip may be implemented by any conventional or other type of temperature  
24 sensor (e.g., RTD, IR, NTC, thermistor, thermocouple, etc.) for direct measurement of fluid  
25 temperatures within the IV line. Sensor wiring 214 is connected to base 250 and extends within  
26 lower member 204. The sensor wiring emerges from a side portion of the lower member below  
27 hinge member 205 and is coupled to a temperature display or monitor device 217. The sensor  
28 wiring transmits signals indicating temperature information from the temperature probe to the  
29 monitor device. The monitor device is substantially similar to the monitor devices described  
30 above and includes a digital display 218 (e.g., LCD or LED) for displaying measured  
31 temperatures and input devices 219 in the form of buttons for controlling temperature values

1 displayed on the digital display. The monitor device may further print, record or provide  
2 indications of temperature measurements as described above.

3 Locking tabs 220 extend from the upper member internal surface with groove 209  
4 disposed between the tabs. Each locking tab 220 is aligned on internal surface 206 of the upper  
5 member with a corresponding generally L-shaped slot 222 defined in the lower member internal  
6 surface with groove 210 disposed between the slots. The locking tabs each include a shoulder  
7 portion 221 that engages with a lower base or “foot” portion of a corresponding L-shaped slot  
8 222 to maintain the locking tabs within the slots in response to pressing the internal surfaces of  
9 the upper and lower members together. Alternatively, device 200 may include any other suitable  
10 locking mechanism to releasably or permanently lock the upper and lower members together.  
11 Upper member 202 further includes a depression 224 disposed and extending longitudinally on  
12 an upper member external surface. Depression 224 is suitably dimensioned to receive a digit  
13 of a user’s hand (e.g., a thumb or forefinger) and provide an enhanced gripping surface for  
14 facilitating closure of the housing by pressing the upper and lower members together upon  
15 placement of a portion of an IV line therebetween. The housing may be disposable and  
16 configured for a single use, while the temperature probe may be removably disposed within the  
17 housing for re-use. In this case, the sensing tip may employ a thermally conductive and  
18 disposable cover for each use to maintain fluid sterility.

19 In operation, upper and lower members 202, 204 are separated from each other such that  
20 groove 210 on internal surface 208 of the lower member is exposed. A selected portion of IV  
21 line 230 is inserted into groove 210 so as to cover sensing tip 213, and upper member 202 is  
22 subsequently pivoted with respect to lower member 204 to align tabs 220 with slots 222. The  
23 upper member is pressed against the lower member (e.g., by using depression 224 as a gripping  
24 surface for the operator’s thumb or forefinger) such that tabs 220 are pressed into slots 222 until  
25 shoulders 221 are locked therein. The pressing force of upper member 202 in a direction toward  
26 lower member 204 simultaneously forces the portion of IV line 230 disposed between the  
27 members toward the lower member internal surface by action of groove 209. This further causes  
28 sensing tip 213 to pierce the IV line for direct exposure to IV fluid therein. The sensing tip  
29 provides a fluid tight seal between the temperature sensing device and the IV line once the line  
30 is pierced. Sensor wiring 214 is subsequently connected to temperature display or monitor device  
31 217 to facilitate display of IV line fluid temperature measured by temperature probe 212.

1        A temperature sensing device of the present invention including a spiral or overlapping  
2 configuration is illustrated in Figs. 6–7. Specifically, a temperature sensing device 300 includes  
3 a generally cylindrical resilient member 302 including a longitudinal channel 310 defined  
4 therethrough. The channel includes dimensions sufficient to receive an operator selected portion  
5 of an IV line 330. The resilient member is noncontinuous along its exterior surface and includes  
6 an exterior end portion 304 and an opposing interior end portion 306. The exterior and interior  
7 end portions overlap, while the resilient member thickness tapers toward the overlapping end  
8 portions, thereby forming a narrow gap 308 therebetween. Resilient member 302 is constructed  
9 of a resilient material (e.g., plastic) that enables end portions 304, 306 to be separated from each  
10 other and facilitate insertion of the IV line within channel 310. A temperature probe 312 is  
11 disposed through resilient member 302 and into channel 310. The probe terminates in a sensing  
12 tip 313 configured as a spike to pierce the wall of the IV line inserted within the channel. The  
13 resilient member has sufficient resiliency to drive the sensing tip through and pierce the line.  
14 Alternatively, the resilient member may include a force application mechanism to provide  
15 sufficient force to enable sensing the tip to pierce the line. The sensing tip may alternatively  
16 obtain a temperature measurement by contacting (e.g., without piercing) the IV line. The  
17 temperature probe further includes sensor wiring 314 extending to a temperature display or  
18 monitor device 317 for displaying temperatures measured by the probe in substantially the same  
19 manner described above. The temperature probe may be implemented by any conventional or  
20 other temperature sensors (e.g., RTD, IR, NTC, thermistor, thermocouple, etc.). The monitor  
21 device is substantially similar to the monitor devices described above and includes a digital  
22 display 318 for displaying measured temperatures and input devices 319 in the form of buttons  
23 for controlling temperature values displayed on the digital display. The monitor device may  
24 further print, record and/or provide various temperature indications as described above.

25        In operation, end portions 304, 306 are separated to enable insertion of an operator  
26 selected portion of IV line 330 within channel 310. The selected IV line portion is inserted  
27 between the separated end portions and into gap 308 while device 300 is manipulated (e.g., by  
28 rotating resilient member 302 around the IV line) to force the IV line into channel 310. As the  
29 IV line enters the channel, sensing tip 313 engages and pierces an exterior surface of the IV line  
30 to directly contact fluid therein. Thus, the device functions to retain the sensing tip against the  
31 IV line to facilitate temperature measurements of fluid flowing within the IV line. Temperature

1 measurement information is transmitted to monitor device 317 to provide various temperature  
2 indications to an operator as described above.

3 A temperature sensing device of the present invention in the form of a fitting securable  
4 to an IV line to measure fluid temperature is illustrated in Fig. 8. Specifically, a temperature  
5 sensing device 400 includes a fitting 401 including a substantially cylindrical base portion 402  
6 and a generally cylindrical projection 406 extending transversely from an intermediate section  
7 of the base portion. The base portion includes open ends 404 and a longitudinal channel defined  
8 therethrough to permit fluid flow through the base portion. The open ends are securable to  
9 selected portions of an IV line 430. The projection similarly includes open ends and facilitates  
10 access to the base portion channel. The fitting typically includes a T-type configuration,  
11 however, any configuration (e.g., a Y-type fitting, cross fitting, coupling, etc.) may be utilized.  
12 Each base portion open end 404 is typically releasably secured to the IV line via a Luer lock 405  
13 or any suitable connector, while the fitting is typically disposable after each use to maintain fluid  
14 sterility. Alternatively, the fitting may be permanently secured to the IV line (e.g., by welding  
15 the ends of the fitting to portions of the IV line) to form a disposable IV line set. The fitting may  
16 be constructed of plastic or any other rigid material suitable for use with IV lines.

17 Projection 406 serves to engage and secure a temperature sensor within the fitting.  
18 Specifically, a temperature probe 410 is disposed within projection 406 and extends partially  
19 within base portion 402. Temperature probe 410 may be implemented by any conventional or  
20 other temperature sensor (e.g., RTD, IR, NTC, thermistor, thermocouple, etc.) and may be  
21 secured within the projection via any securing mechanisms (e.g., friction fit, adhesives, etc.). The  
22 probe is disposed within the projection in a manner that provides a fluid tight seal with the fitting  
23 channel to maintain IV fluid within the fitting. Sensor wiring 414 is connected to probe 410 and  
24 extends from the fitting to a temperature display or monitor device 417. The monitor device is  
25 substantially similar to the monitor devices described above and includes a digital display 418  
26 for displaying measured temperatures and input devices 419 in the form of buttons for controlling  
27 temperature values displayed on the digital display. The monitor device may further print, record  
28 and/or provide various temperature indications as described above.

29 In operation, device 400 is attached to an IV line by securing base portion open ends 404  
30 to operator selected portions of IV line 430. Upon securing the fitting to the IV line in a fluid  
31 tight relationship, IV fluid is permitted to flow through the IV line and fitting. Sensor wiring 414

1 is connected to temperature monitor 417. Temperature probe 410 contacts fluid flowing through  
2 the fitting and directly measures the temperature of the fluid. The probe transmits the measured  
3 temperature information via the sensor wiring to the monitor device for display of fluid  
4 temperature. Upon completion of an IV fluid temperature measurement or medical procedure,  
5 the sensor wiring may be disengaged from the monitor, while the fitting is removed from the IV  
6 line and discarded.

7       The temperature sensing fitting may alternatively facilitate releasable engagement of the  
8 temperature probe as illustrated in Figs. 9A-9B. Specifically, a sensing device 500 includes a  
9 fitting 501 with substantially the same configuration as fitting 401 described above. Fitting 501  
10 includes a substantially cylindrical base portion 502 and a generally cylindrical projection 506  
11 extending transversely from an intermediate section of the base portion. The base portion  
12 includes open ends 504 and a longitudinal channel defined therethrough to permit fluid flow  
13 through the base portion. The projection includes open ends and facilitates access to the base  
14 portion channel. Base portion open ends 504 are securable to selected portions of an IV line 530  
15 via Luer locks 505 or other connectors in substantially the same manner described above for  
16 device 400. A thermally conductive receptacle 510 is secured within projection 506 and extends  
17 partially within base portion 502 for contacting fluid flowing within the base portion channel.  
18 Receptacle 510 may be constructed of stainless steel or any other material having suitable  
19 thermal conductivity, and may be secured within the projection via any suitable securing  
20 techniques (e.g., friction fit, adhesives, etc.). The receptacle includes a generally cylindrical body  
21 520 with a closed distal end that extends partially within the base portion and an open proximal  
22 end for receiving a temperature probe 512 as described below. A flange 522 extends radially  
23 from the open proximal end of the receptacle to engage an interior surface of the projection. The  
24 receptacle includes dimensions sufficient to provide a fluid tight seal between the projection and  
25 base portion channel to maintain fluid within the channel. A temperature probe 512 is  
26 removably inserted within the receptacle with the distal end of the probe in contact with the  
27 receptacle closed end. The probe may be secured within the receptacle via friction fit, a locking  
28 or securing mechanism or any other securing techniques. Sensor wiring 514 connects the probe  
29 to a temperature display or monitor device 517. The monitor device is substantially similar to  
30 the monitor devices described above and displays temperatures measured by temperature probe  
31 512 on a digital display 518 in accordance with manipulation of input devices or buttons 519.

1 The monitor device may further print, record and/or provide various temperature indications as  
2 described above. The probe may be re-used with new fittings, while the receptacle of each new  
3 fitting maintains the sterile field for fluid flowing within that fitting.

4 In operation, device 500 is attached to an IV line by securing base portion open ends 504  
5 to selected portions of IV line 530. Upon securing the fitting to the IV line in a fluid tight  
6 relationship, IV fluid is permitted to flow through the line and fitting. As fluid flows within the  
7 fitting, the receptacle closed end contacts the fluid, while the receptacle conducts thermal energy.  
8 Temperature probe 512 is inserted into and contacts the closed end of receptacle 510 to measure  
9 the temperature of the receptacle. Temperature signals are transmitted from the probe through  
10 sensor wiring 514 to the monitor device for display of fluid temperature to the operator. After  
11 completion of an IV fluid temperature measuring or medical procedure, probe 512 is removed  
12 from receptacle 510 of the fitting, while the fitting may be discarded. Since the temperature probe  
13 does not directly contact fluid flowing within the IV line, the system facilitates repeated use of  
14 the probe with additional IV lines without the need for sterilization.

15 The temperature sensing device may employ a securing mechanism for releasably  
16 engaging a temperature probe as illustrated in Figs. 10-11 and 12A – 12B. Specifically, a  
17 sensing device 600 includes a fitting 601 with substantially the same configuration as fitting 501  
18 described above. Fitting 601 includes a substantially cylindrical base portion 602 and a  
19 generally cylindrical projection 606 extending transversely from an intermediate section of the  
20 base portion. The base portion includes open ends 604 and a longitudinal channel defined  
21 therethrough to permit fluid flow through the base portion. The projection includes open ends  
22 and facilitates access to the channel. Base portion open ends 604 are securable to portions of an  
23 IV line 630 via Luer locks 605 or other connectors in substantially the same manner described  
24 above for device 500. A thermally conductive receptacle 610, substantially similar in  
25 configuration to receptacle 510 described above, is secured within projection 606 and extends  
26 partially within base portion 602 for contacting fluid flowing within the base portion channel.  
27 The receptacle includes a generally cylindrical body with a closed distal end that extends  
28 partially within the base portion and an open proximal end for receiving a temperature probe 612  
29 as described below. A flange 622 extends radially from the open proximal end of the receptacle  
30 to engage an interior surface of the projection. The receptacle includes dimensions sufficient to

1 provide a fluid tight seal between the projection and base portion channel to maintain fluid within  
2 the channel in substantially the same manner described above.

3 A temperature probe 612 is secured to fitting 601 and disposed within receptacle 610 via  
4 a securing member or cap 616. Specifically, cap 616 may be constructed of any suitable  
5 materials (e.g., plastic) and includes a generally S-shaped configuration with ends tapering in  
6 thickness to facilitate enhanced gripping. The cap includes a channel 624 defined in the cap  
7 interior and extending from a cap proximal portion to a cap distal surface. The channel is  
8 dimensioned to receive and retain the fitting projection. Temperature probe 612 is disposed  
9 within the cap channel and extends beyond the cap distal surface. The channel is dimensioned  
10 to receive and retain the fitting projection, while the probe includes transverse cross-sectional  
11 dimensions slightly less than those of receptacle 610 to enable insertion of the probe within the  
12 receptacle as described below. The cap proximal surface includes a support structure 625  
13 disposed thereon to guide sensor wiring 614 and provide structural support for cap 616. Sensor  
14 wiring 614 is connected to probe 612 and extends from the probe through the cap proximal  
15 surface and support structure 625 to a temperature display or monitor device 617. The monitor  
16 device is substantially similar to the monitor devices described above and displays temperatures  
17 measured by temperature probe 612 on a digital display 618 in accordance with manipulation of  
18 input devices or buttons 619. The monitor device may further print, record and/or provide  
19 various temperature indications as described above.

20 Projection 606 further includes tabs 607 disposed toward the projection proximal end and  
21 angularly spaced apart by approximately one-hundred eighty degrees. Channel 624 includes  
22 transverse cross-sectional dimensions slightly greater than those of the projection, but less than  
23 those of the projection portions containing tabs 607. In order to accommodate the projection tab  
24 portions, channel 624 includes grooves 615 defined therein and angularly spaced apart by  
25 approximately one hundred eighty degrees. The grooves extend from the cap distal surface  
26 toward the channel proximal end and include dimensions suitable to accommodate the tabs.  
27 Recesses or notches 617 are defined at the proximal ends of the respective grooves and are  
28 dimensioned to receive and retain corresponding tabs 607. The transverse cross-sectional  
29 dimensions of the projection tab portions are slightly greater than those of the channel with  
30 grooves 615, but less than the dimensions of the channel with recesses 617. The grooves  
31 basically compress the projection tab portions due to projection resiliency to receive those

1 portions in a snug fashion and to guide the tab portions toward recesses 617. The projection  
2 resiliency causes the projection to expand upon reaching recesses 617, thereby forcing tabs 607  
3 in a locking engagement with those recesses. Locking of tabs 607 in corresponding recesses 617  
4 assures that the temperature probe is positioned in contact with the receptacle within the  
5 projection. In addition, grooves 615 may taper in depth toward corresponding recesses 617 to  
6 assist in guiding tabs 607 through the grooves and into the recesses.

7         Tabs 607 are each configured to be fractured and removed from the fitting. This prevents  
8 the fitting from being re-used for temperature measurement, thereby maintaining fluid sterility.  
9 The tabs may be removed from the fitting by rotating the cap with respect to the projection when  
10 the tabs are disposed within recesses 617. The recesses inhibit tab motion, thereby enabling the  
11 rotational force applied to the cap to fracture and remove the tabs from the fitting. Recesses 617  
12 may further be elongated transversely on the cap interior surface to permit initial free rotational  
13 movement of cap 616 and enhance application of rotational force to the cap for fracturing the  
14 tabs.

15         In operation, temperature device 600 is connected to an operator selected portion of IV  
16 line 630 as described above. Securing cap 616 is disposed over fitting projection 606 with  
17 temperature probe 612 disposed within the projection and channels 615 aligned with tabs 607.  
18 The cap is forced distally onto the projection to allow tabs 607 to travel proximally through  
19 channels 615 and be secured within recesses 617, while the temperature probe is inserted into  
20 receptacle 610. Upon securing the tabs within the recesses, the cap is effectively locked on the  
21 fitting with the temperature probe contacting the interior surface of receptacle 610. Fluid is  
22 permitted to flow within the fitting and directly contacts a surface of the receptacle closed end  
23 extending within base portion 602. The receptacle conducts thermal energy and the receptacle  
24 temperature is measured by the temperature probe and subsequently displayed on the monitor  
25 device. Once the temperature measurement or medical procedure is completed, the locking  
26 engagement between the cap and fitting may be released by rotating the cap relative to the  
27 projection. This causes the tabs to fracture and be removed from the projection, thereby  
28 disengaging the cap and temperature probe from the fitting. Thus, device 600 facilitates  
29 temperature measurement without direct contact of fluid and employs a temporary locking  
30 arrangement between the temperature probe and the fitting, thereby allowing reuse of the probe  
31 and securing cap with additional fittings without the need for sterilization. Further, the fitting

1 is limited to a single use for temperature measurement to prevent contamination of sterile fluid.  
2 In addition, the tabs may notify an operator of fitting use. Basically, since the securing cap  
3 removes the projection tabs after use, the absence of those tabs on the fitting indicates that the  
4 fitting has been previously used and may compromise sterile conditions when used for another  
5 application.

6 A temperature sensing device in the form of a fitting typically utilized for permitting  
7 injection of fluids into an IV line is illustrated in Fig. 13. Specifically, a temperature sensing  
8 device 700 includes a fitting 701 with a substantially cylindrical base portion 702 and a  
9 generally cylindrical inlet portion 706 extending from, and at an approximate forty-five degree  
10 angle relative to, an intermediate section of the base portion. The base and inlet portions each  
11 include a longitudinal channel defined therethrough to permit fluid flow through those portions.  
12 The fitting inlet portion receives an IV line 730 connected to a fluid source, while the base  
13 portion distal end is secured to an IV line 740 for conveyance of fluid to a patient. The fitting  
14 may be secured to the IV line portions via locks or connectors in substantially the same manner  
15 described above. The fitting typically includes a Y-type configuration, however, any type of  
16 fitting configuration may be employed.

17 The proximal section of the base portion includes transverse cross-sectional dimensions  
18 greater than those of the base portion distal section and houses a flexible membrane 710. The  
19 flexible membrane is constructed of a penetrable nylon or other suitable material that provides  
20 a barrier for permitting insertion and removal of a syringe needle or other instrument  
21 therethrough, while maintaining a fluid tight seal at the base portion proximal end. A  
22 temperature probe 712 is inserted through the membrane and into the fitting to measure the  
23 temperature of fluids flowing therein. In particular, probe 712 is configured in the form of a  
24 syringe needle and includes a sensing tip 713 disposed at a probe distal end and a handle 715  
25 disposed at a probe proximal end. The handle provides a gripping surface for an operator when  
26 inserting the sensing tip through the membrane. The temperature probe may be implemented by  
27 any conventional or other temperature sensor (e.g., RTD, IR, NTC, thermistor, thermocouple,  
28 etc.). Sensor wiring 714 extends from the probe to a temperature display or monitor device 717.  
29 The monitor device is substantially similar to the monitor devices described above and displays  
30 the measured temperatures on a digital display 718 in accordance with manipulation of input

1 devices or buttons 719. The monitor device may further print, record and/or provide various  
2 temperature indications as described above.

3 In operation, fitting 701 is secured to an operator selected portion of an IV line as  
4 described above. Temperature probe 712 is inserted through flexible membrane 710 at the base  
5 portion proximal end until sensing tip 713 is completely disposed within the fitting and in contact  
6 with fluid flowing therein. The probe is connected to the monitor device and fluid temperatures  
7 are measured and subsequently displayed as described above. Upon completion of a temperature  
8 measurement or medical procedure, the probe may be removed from the fitting and sterilized and  
9 reused. Alternatively, device 700 may include a sheath (not shown) constructed of stainless steel  
10 or any other suitable thermally conductive material to cover the sensing tip during use. The  
11 sheath maintains sterility of the fluid and permits reuse of the sensing tip without sterilization.  
12 The sheath may either be discarded or sterilized and reused after completion of a temperature  
13 measurement or medical procedure.

14 It will be appreciated that the embodiments described above and illustrated in the  
15 drawings represent only a few of the many ways of implementing a temperature sensing device  
16 for selectively measuring temperature at desired locations along an intravenous fluid line.

17 The temperature sensing device including the housing and cap members may be of any  
18 shape or size and may be constructed of any suitable materials. The device may be secured at  
19 any locations along an IV or any other fluid line. The housing and cap members may be of any  
20 quantity, shape or size, and may be constructed of any suitable materials. The housing member  
21 channel may be of any quantity, shape or size and may be defined within the housing member  
22 at any location and extend in any direction. The sensor and fluid line receiving areas may be of  
23 any quantity, shape or size, may be defined at any suitable locations and may receive the sensor  
24 and fluid line in any manner (e.g., friction fit, securing mechanism, etc.). The cap member may  
25 be attached to the housing member via any quantity of any type of fasteners or connectors or in  
26 any other manner. The pin and apertures may be of any quantity, shape or size. The apertures  
27 may be defined in the housing and cap members at any desired locations. The housing member  
28 may further include any suitable locking mechanism to releasably or non-releasably lock the fluid  
29 line within the housing member.

30 The temperature sensors or probes of the temperature sensing devices described above  
31 may be implemented by any quantity of any type of conventional or other temperature measuring

1 devices (e.g., RTD, IR, NTC, thermistors, thermocouples, etc.). The sensors may be of any  
2 shape or size to accommodate a particular application. The temperature display or monitor  
3 devices described above may be implemented by any quantity of conventional or other processing  
4 devices or circuitry to determine and display fluid temperature. The display devices may include  
5 processors and various indicators (e.g., visual, audio, speech synthesis, etc.) to indicate the  
6 measured temperature and notify of occurrence of any type of temperature or other conditions.  
7 The temperature sensors may communicate with the display devices via any communications  
8 medium (e.g., wired, wireless, IR, etc.). The display devices may include any quantity of any  
9 type of conventional or other displays (e.g., LCD, LED, etc.) of any size or shape disposed at any  
10 suitable locations. The display devices may display any desired information (e.g., time,  
11 temperature, date, patient information, etc.), and may be disposed at any locations (e.g., near or  
12 away from the temperature sensing device) within view of an operator. The display device may  
13 employ any type of input devices (e.g., keypad, buttons, voice recognition, touch screen, etc.) and  
14 may further include any types of processing, printing and/or recording devices to process, print  
15 and/or record any desired information in any desired fashion.

16       The temperature sensing device in the form of a holder may be of any shape or size and  
17 may be constructed of any suitable materials. The base, platform and prongs may be of any  
18 quantity, shape or size, may be connected or arranged in any fashion and may be constructed of  
19 any suitable materials. The platform may include any quantity of any type of fastening  
20 mechanism (e.g., gel, adhesives, hook and loop fasteners, etc.) to secure the holder to any portion  
21 of a patient (e.g., arm, leg, etc.). The fastening mechanism may be disposed at any locations on  
22 the platform or holder. The grooves defined in the prongs may be of any quantity, shape or size,  
23 may be defined at any suitable locations and may extend in any desired direction. The prongs  
24 may include any suitable configuration and extend in any desired directions. The prong  
25 projections may be of any quantity, shape or size and may be disposed at any suitable locations  
26 on the prongs or holder. The base groove may be of any quantity shape or size, may be defined  
27 in the base or holder at any desired locations and may extend in any directions. The groove may  
28 receive and secure any type of fluid line in any desired manner (e.g., friction fit, securing  
29 mechanism, etc.). The holder may include any configuration to secure the temperature sensor  
30 and/or fluid line in any desired manner.

1       The temperature sensing device including the upper and lower members may be of any  
2 quantity, shape or size and may be constructed of any suitable materials. The upper and lower  
3 members may be of any quantity, shape or size and may be constructed of any suitable materials.  
4 The upper and lower members may be attached to each other via any type of conventional or  
5 other securing mechanism (e.g., hinges, brackets, etc.). The grooves defined in the upper and  
6 lower members may be of any quantity, shape or size and may be defined in the members at any  
7 desired locations and may extend in any desired directions. The grooves may form a channel of  
8 any quantity, shape or size to accommodate any type of fluid line. The temperature sensor may  
9 be of any quantity and may be disposed within the upper and/or lower member at any suitable  
10 locations. The temperature sensor base and supports may be of any quantity, shape or size and  
11 may be constructed of any suitable materials. The sensing tip may be of any shape or size, may  
12 be constructed of any suitably thermally conducting materials and may be configured and/or  
13 disposed to puncture and/or contact the fluid line to measure fluid temperature.

14       The tabs and slots of the upper and lower members may be of any quantity, shape or size  
15 and may be disposed on the upper and lower members at any desired locations. The upper and  
16 lower members may include any conventional or other locking mechanism to permanently or  
17 releasably secure the members together. The depression may be of any quantity, shape or size,  
18 may be disposed at any desired locations on the upper and/or lower members and may receive  
19 any quantity of portions of an operator body (e.g., hand, fingers, etc.). A cover may be employed  
20 for use with the temperature sensor to maintain fluid sterility and permit re-use of the sensor.  
21 The cover may be of any quantity, shape or size and may be constructed of any suitable thermally  
22 conducting materials.

23       The temperature sensing device including a spiral configuration may be of any quantity,  
24 shape or size and may be constructed of any suitable materials. The device may include any  
25 resilient member configured in any fashion to wrap around a fluid line. The channel may be of  
26 any shape or size and may extend in any desired direction. The gap between the member ends  
27 may include any suitable dimensions. The temperature probe may be disposed on or through the  
28 resilient member at any desired locations, while the sensing tip may be of any shape or size, may  
29 be constructed of any suitably thermally conducting materials and may be configured and/or  
30 disposed to puncture and/or contact the fluid line to measure fluid temperature. The sensing

1 device may include any type of conventional or other force application mechanism (e.g., spring,  
2 driving mechanism, etc.) to drive the sensing tip to pierce the fluid line.

3       The temperature sensing device in the form of a line fitting may be of any quantity, shape  
4 or size, may be constructed of any suitable materials and may be disposed at any suitable  
5 locations along the line. The fitting base and projection may be of any quantity, shape or size and  
6 may be constructed of any suitable materials. The base channel may be of any shape or size, may  
7 be defined in the base at any locations and extend in any desired directions. The fluid line may  
8 be secured to the fitting via any conventional or other locks or connectors. The base and  
9 projection may be arranged or connected in any fashion, while the fitting may have any suitable  
10 configuration (e.g., T-type fitting, Y-type fitting, cross fitting, coupling, etc.). The fitting may  
11 be included within and permanently or releasably connected to a disposable IV line set. The  
12 temperature probe may be disposed within the fitting projection in any manner via any  
13 conventional or other securing mechanisms (e.g., friction fit, adhesives, clamp, threaded  
14 engagement, etc.). The fitting may include a receptacle to maintain fluid sterility and permit re-  
15 use of the temperature probe. The receptacle may be of any quantity, shape or size, may be  
16 constructed of any suitably thermally conductive materials and may be disposed at any locations  
17 within the projection or fitting suitable to contact or thermally conduct heat from fluid flowing  
18 within the fitting. The receptacle body and flange may be of any quantity, shape or size and may  
19 be constructed of any suitable materials. The temperature probe may be secured within the  
20 receptacle via any conventional or other securing techniques (e.g., friction fit, threaded  
21 engagement, securing mechanism, etc.). Similarly, the receptacle may be secured within the  
22 projection or fitting via any conventional or other securing techniques (e.g., friction fit,  
23 adhesives, threaded engagement, securing mechanism, etc.).

24       The securing cap may be of any quantity, shape or size and may be constructed of any  
25 suitable materials. The cap channel may be of any shape or size, may be defined at any cap  
26 locations and may extend in any desired directions. The temperature probe may be secured  
27 within the securing cap via any conventional or other securing techniques (e.g., friction fit,  
28 threaded engagement, securing mechanism, etc.). The projection tabs may be of any quantity,  
29 shape or size, may be constructed of any desired materials and may be disposed at any locations  
30 on the projection or fitting. The channel grooves and notches may be of any quantity, shape or

1 size and may be defined at any locations. The tabs may be secured to the projection or fitting in  
2 any manner enabling fracture or removal of the tabs.

3 The temperature sensing device in the form of an injection fitting may be of any quantity,  
4 shape or size, may be constructed of any suitable materials and may be disposed at any suitable  
5 locations along the line. The fitting base and inlet portions may be of any quantity, shape or size  
6 and may be constructed of any suitable materials. The base and inlet portion channels may be of  
7 any shape or size, may be defined in the respective portions at any locations and extend in any  
8 desired directions. The fluid line may be secured to the fitting via any conventional or other  
9 locks or connectors. The base and inlet portions may be arranged or connected in any fashion,  
10 while the fitting may have any suitable configuration (e.g., T-type fitting, Y-type fitting, cross  
11 fitting, coupling, etc.). The fitting may be included within and permanently or releasably  
12 connected to a disposable IV line set. The temperature probe may include any type of  
13 configuration, but is preferably in the form of a syringe, needle or other configuration suitable  
14 to penetrate the barrier. The membrane or barrier may be constructed of any suitable nylon or  
15 other material. The probe sensing tip and handle may be of any shape or size, and may be  
16 disposed at any suitable locations on the probe. The temperature probe may be employed with  
17 a sheath or covering to maintain fluid sterility and permit re-use of the probe. The sheath may  
18 be of any quantity, shape or size and may be constructed of any suitable thermally conducting  
19 materials.

20 It is to be understood that the present invention is not limited to the specific  
21 configurations or applications described above, and may be utilized to determine the temperature  
22 of a fluid at any desired location within a fluid line. For example, the temperature sensors or  
23 probes may be embedded within, or entirely or partially wrapped about, the fluid line wall to  
24 measure and provide fluid temperature to the monitor device. Alternatively, the temperature  
25 sensors or probes may be wrapped entirely or partially about a sensing device or holder, or may  
26 be disposed within the fluid line (e.g., attached to the fluid line inner diameter). The temperature  
27 sensors and probes may be secured to the fluid line or sensing device or holder via any suitable  
28 fastening techniques (e.g., snap type fasteners, adhesives, etc.), and may cover any portion of the  
29 fluid line and/or sensing device or holder.

30 The temperature sensing devices described above may be employed with any types of  
31 infusion apparatus, such as the apparatus shown in Fig. 2. The temperature sensing devices

1 described above may be placed at any desired locations along a fluid line (e.g., attached to those  
2 locations or moved along the fluid line) via any suitable attachment or placement techniques to  
3 measure temperature of fluid at those locations. The manners of operation of the temperature  
4 sensing devices described above may be modified in any fashion to perform a fluid temperature  
5 measurement. A fluid line may include any quantity of temperature sensing devices or  
6 corresponding components (e.g., temperature sensors or probes, housings, fittings and/or monitor  
7 devices) where temperature measurements may be combined in any fashion (e.g., averaged,  
8 weighted, etc.) to determine a fluid temperature.

9 It is to be understood that the terms "top", "bottom", "front", "rear", "side", "height",  
10 "length", "width", "upper", "lower" and the like are used herein merely to describe points of  
11 reference and do not limit the present invention to any particular orientation or configuration.

12 From the foregoing description, it will be appreciated that the invention makes available  
13 a novel temperature sensing device for selectively measuring temperature at desired locations  
14 along an intravenous fluid line, wherein a temperature sensing device is selectively secured to  
15 an intravenous fluid line at any desired location and provides temperature measurements to a  
16 monitor device to display the measured fluid temperature to an operator.

17 Having described preferred embodiments of a new and improved temperature sensing  
18 device for selectively measuring temperature at desired locations along an intravenous fluid line,  
19 it is believed that other modifications, variations and changes will be suggested to those skilled  
20 in the art in view of the teachings set forth herein. It is therefore to be understood that all such  
21 variations, modifications and changes are believed to fall within the scope of the present invention  
22 as defined by the appended claims.